



Ministry of
Transportation and
Communications

MI-70

**VIRGINIA, WEST VIRGINIA
AND PENNSYLVANIA
QUALITY ASSURANCE SYSTEMS**

**MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE**

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P. Korgemagi and G. Cautillo

ENGINEERING MATERIALS OFFICE
BITUMINOUS SECTION

November, 1984

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1.0 INTRODUCTION

The states of Virginia, West Virginia and Pennsylvania were visited by P. Korgemagi and G. Cautillo from September 24 to 28, 1984 to assess mature quality assurance systems. These states were chosen because their systems have been in place from 3 to 10 years and are fairly similar to the one proposed for Ontario.

The plan was to spend one to one and a half days with each construction materials engineer and members of his staff to discuss their systems.

One of the main issues presently of concern to MTC is the credibility of our sampling and testing of hot mix. The specific topics that were discussed were sampling, splitting to test size, preparation of test sample and testing procedures. The credibility of test results in cases where the testing is done by the contractor was also addressed.

At this key point in the development of bituminous performance specifications, specific information on price adjustment schemes, acceptance parameters, the handling of challenged test results, etc. was needed. B-138 is meeting the needs for which it was developed, however, the full system should be developed as soon as possible.

Following, in point form are the issues discussed.

2.0 VIRGINIA

State officials interviewed

J. E. Galloway - Assistant State Materials Engineer
J. T. Love - Materials Engineer

Contractor interviewed

B. C. Lambeth - Apac Virginia Inc.

2.1 Quality Assurance System - General

- Description of system
 - all acceptance tests performed by contractor
 - state monitors contractor by taking 2 samples/week
 - purpose - check on contractors - equipment
 - sampling procedures
 - testing procedures
- contractor obtains samples from truck box and quarters down to test size
- state usually obtains monitor samples from paver hopper (not from road because of tack coat)
- state monitor samples and contractor acceptance samples are compared with aid of a computer. A significant difference results in drill to identify why.
- the state reserves the right to use monitor samples for acceptance if problems are encountered
- the state is investigating the use of field Marshall samples as monitor samples as well.
- state uses road inspector, but no plant inspector
- most plants are automated.

2.2 Administration

- contractor tests and monitor tests are fed into computer. If match is not established activities are triggered to identify what is wrong. If problem not resolved at this point samples are taken from the road for referee testing.
- contractor or state may request coring to referee results.
- 0.2% AC is deducted to account for tack coat.
- decision to accept lot is based on a combination of field/central laboratory input. Final decision made by contract administration.
- acceptance is made on a lot by lot basis but an adjustment is also made at the end of the project if variability was excessive.

TABLE 11-13
PROCESS TOLERANCE

Number Test*	Tolerance On Each Laboratory Sieve and Asphalt Content - Percent									
	Top Size	1 1/2"	3/4"	3/8"	3/16"	No. 4	No. 8	No. 30	No. 50	No. 200 A.C.*
1	0.0	±10.0	±10.0	±10.0	±10.0	±10.0	±9.0	±8.0	±5.0	±3.0 ±0.80
2	0.0	± 7.1	± 7.1	± 7.1	± 7.1	± 7.1	±6.4	±5.7	±3.6	±2.1 ±0.57
3	0.0	± 5.6	± 5.6	± 5.6	± 5.6	± 5.6	±5.0	±4.4	±2.8	±1.7 ±0.44
4	0.0	± 5.0	± 5.0	± 5.0	± 5.0	± 5.0	±4.5	±4.0	±2.5	±1.5 ±0.40
8	0.0	± 3.6	± 3.6	± 3.6	± 3.6	± 3.6	±3.2	±2.9	±1.8	±1.1 ±0.29

*Asphalt content will be measured as extractable asphalt.

- if verification tests show concurrence with contractor tests then his tests are used for acceptance, if outside of the 33% confidence limits everything is checked and referee system is used to determine payment (see Virginia test method VTM-59-84 available from Bituminous Section, EMO).

2.3 Acceptance Criteria

- A.C. and some sieves. The number of sieves depends on material type.
- state eventually wants to switch to a system where all sieves are controlled but penalties are set on only a few
- multiple deficiency are combined using severity factors

Sieve No.		Adjustment Points For Each 1% That The Gradation Is Outside The Process Tolerance Permitted in Table II-13
Va	MTC	
2"	53.0	1
1½"	37.5	1
1"	26.5	1
¾"	19.0	1
½"	13.2	1
3/8"	9.5	1
4	4.75	1
8	2.36	1
30	6.00	2
50	3.00	2
200	75	3

- price reduction based on a lot by lot plus at end of job adjustment is made for excessive variability

TABLE II-14

STANDARD DEVIATION

Sieve No. & A.C.	Standard Deviation		
	1 adjustment point for each sieve size & A.C.	2 adjustment points for each sieve size & A.C.	3 adjustment points for each sieve size & A.C.
1½"	4.6 - 5.5	5.6 - 6.5	6.6 - 7.5
¾"	4.6 - 5.5	5.6 - 6.5	6.6 - 7.5
½"	4.6 - 5.5	5.6 - 6.5	6.6 - 7.5
3/8"	4.6 - 5.5	5.6 - 6.5	6.6 - 7.5
4	4.6 - 5.5	5.6 - 6.5	6.6 - 7.5
8	4.1 - 5.0	5.1 - 6.0	6.1 - 7.0
30	3.6 - 4.5	4.6 - 5.5	5.6 - 6.5
50	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0
200	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
A.C.	0.33 - 0.42	0.43 - 0.52	0.53 - 0.62

- during project the state looks at the overall variability and advises contractor of potential penalty.

2.4 Price Reduction

- The magnitude of the adjustment points is based on experience.
- price reduction up to 25% of bid price. If price reduction exceeds 25% the lot removed and replaced
- performance specs are in effect in addition to price reduction, i.e. regardless of lot by lot acceptance if the road fails while the contract is active the contractor is responsible.

2.5 Verification Testing

- see Administration and Acceptance Criteria
- both parties can evoke referee testing
- cost of referee testing borne by the requestor
- Materials people who are responsible for monitoring deal with certified technician. If he is not available while the plant is in operation contract administration orders the shut down of the plant.

2.6 Training and Certification

- contractor and state people are trained and certified by state.
- certification was started in 1963.
- instructors include officials from state and from the paving association.
- course is 2-1/2 to 3 days long, same course given to the contractor and state people.
- certification is valid for 4 years, recertification is needed after that.

- once recertified 2 times, inspector needs to attend 1/2 day refresher on latest policies. No examination at end of 1/2 day course.
- certification section consists of one engineer and one secretary who are assisted by Materials people during peak training periods.
- state prefers to go into stricter exam than at present.
- state inspector does not interfere with contractor's operation but as in the case of Ontario advises him if problems are evident.
- list of "Certified Technicians" is made available to District Engineers.
- small contractors rely on testing companies for certified technicians.

2.7 Asphalt Cement

- contractor supplies AC.
- state draws 1 sample per storage tank at supply terminal and tests within 2-3 days.
- state not entirely pleased with current system.
- producer can ship on certification but can run into problems if subsequent testing reveals problems.
- problems are more prevalent with emulsions and cutback rather than AC.
- AC included in hot mix item.
- state and contractor claim they are finding that up to 0.5% AC can be lost between plant and road due to evaporation of "light ends".
- routine AC tests: viscosity, penetration, ductility, flash; occasionally going to other tests.

- routinely are having problems with tests on samples taken at the plant and from the road. At plant may get 5.8% AC, at road may get 5.3%. Possible causes: evaporation of light ends, water in aggregates.

2.8 Aggregates

- most are from established stable sources.
- routinely tested for quality once a year.
- wayside pits - quality tests run by state before material can be used.

2.9 Credibility

- people have to be trusted. A lot of highway people have had problems dealing with this.
- state suspects that not all samples are totally "good".
- if caught cheating, technician loses certification.
- under system only possible to catch habitual cheater.
- contractors are presently getting price reductions based on their test results therefore unlikely that serious cheating is taking place.

2.10 Laboratory

- laboratory supply is a bid item, at first had realistic figures now all bids are coming in at \$1.00 because all contractors have them.
- only one laboratory is used for acceptance testing, if 2 have to be used results are always kept separate therefore do not run into problems of interlaboratory correlation etc.
- see Virginia spec 517.

2.11a Density

- pavement frozen with CO₂ then saw cut sample taken by dry sawing so that no correction need to be made for moisture or fines in sample.

- samples are 2-4", minimum of 7 samples per lot are taken (random location selected by state inspector).
- sampling by contractor, testing by state.
- if lot average falls below 92.5% of theoretical density (Rice Method) or standard deviation exceeds 1.3 the job is shut down until contractor corrects problem.
- state not entirely happy with above, will look at establishing a roller pattern based on sawn sample but checked with the nuclear gauge.
- earlier research showed good correlation between sawn samples and cores.

2.11b Thickness

- checked and controlled in the field (same as MTC).
- not used in QA System.

2.12 Future of ERS

- good move for state.
- still evolving.

2.13 Reaction by Contractors

- afraid and reluctant at first.
- higher cost at first because of requirement of quality assurance technician (since introduction contractors have found this man to be a money saver).
- when system first started it was a voluntary program and a few large contractors went in, others followed.
- last year system made mandatory (some contractors had to be pushed).
- next year contractors will be required to do field Marshalls.

- often work for contractor has been done by retired or layed-off state people.

2.14, 15 Sampling and Testing

- few problems have been attributed to people and procedures but are having a lot of problems with testing equipment (manufacturers are supplying a lot of shoddy and substandard equipment).
- state requires that all testing equipment meets the minimum AASHTO requirements.
- sample size not exactly as per AASHTO but takes into account aggregate size. Test sample size ranges from 1 kg for fine mix to 2 kg for coarse.
- reflux extractor used by State and by contractor, extraction time ranges from 4 hours to 2-3 days. 20% alcohol is used to aid in filtering.
- this year have started taking 15-20 lb sample which is quartered down to test sample size (sample has to be large enough to ensure 2 splits) - (test portions).
- fine filter paper is used (same as used in Ontario) so that no correction for fines is necessary. Filter paper is ashed for fines.
- aggregates are not washed during sieving.
- will experiment with nuclear gauge to determine AC content but still have to go through extraction because of gradation.
- centrifuge extractor occasionally used by contractors for a quick check.
- breakage of reflux jars is a problem.

2.16 Marshall Samples

- 3 field samples (briquettes) taken every 10,000 t and averaged

- requirements

voids	3- 6%
VMA	14-19%
VFA	75-80%
flow	0.8-0.19 inch

VFA = voids filled with asphalt.

- if field Marshall fails, contractor is allowed to make adjustments, mix tested and if again fails the plant is shut down.
- this year state is sticking to above limits, next year will probably relax these limits.
- having problems with equipment that does not meet specifications.

2.17 Mix Design

- by contractor - state approves on condition that production mix meets all requirement.
- contractor required to meet all requirements including VMA, if he is adding baghouse fines he better know what he is doing.
- state uses mostly granitic aggregates and absorption is not a serious problem.
- little experience with steel slag.

2.18 Privatization of Mix Design

- privatization of mix design started with staff cutbacks. State people were laid off then gave mix design to contractor because state did not have personnel to do work.
- as work picked up moved quickly to QA system to handle workload.

2.19 Segregation

- largely a visual check, no specific criteria is used.

2.20 Coring

- see item 2.11.
- road samples obtained by sawing are normally used only for density check.
- if have to use sawn samples or cores to determine gradation the cut edges are removed.

2.21 Rutting

- the introduction of density requirements has created the situation where extra AC is put into mix to increase density resulting in low stability.
- without plant inspector there is no one to check use of releasing agents - sometimes dents in truck box are filled with oil, maybe will introduce specs limiting the use of release agents.
- presently 50 blow Marshall is used, 75 blow Marshall will be investigated.
- moving to AC-30 from AC-20.
- using ratio of 1:1 #200 to AC.
- problem near toll booths, for these specific locations may look at concrete or high stability mixes.
- lime helps in high stability mixes.
- traffic loads are increasing every day.

2.22 Recycling

- permit up to 25% in any mix including surface courses.
- RHM must meet all specs for normal hot mix.
- contractor keeps all RAP, state officials a bit reluctant to part with it.

- no pre-engineering done by state, since RHM is a contractor's option he carries out any investigation.
- first trial in 1977, 2 in 1980 all performing ok.
- all RAP has been milled.
- state would prefer to see more milling done to improve cross-section.
- frost penetration 16-18" with lots of cycles.

2.23 Stripping

- big problem.
- in past, state tested additives against known strippers (dolomite) if passed additive put on approved list. Once on list material checked occasionally, later found that manufacturers were changing products without telling state.
- now up to contractor to determine concentration and choice of additives.
- additives subject to boiling test (Test VTM-62-84 available from Bituminous Section, EMO).
- state interest - does additive work? at what concentration?
- state anticipate that contractors and manufactures will co-operate to find best solution.
- not certain if above has cured field problems, will continue to study.
- Georgia has gone completely to lime, Virginia looking at this.

2.24 Visit to Contractor

During visit to Virginia, a quarry asphalt plant and laboratory operated by APAC-Virginia was visited. Mr. Bobby Lambeth outlined the following:

- have had problems with getting different AC content at plant versus the road.
- APAC has been doing own testing for 3 years, had gone into QA System voluntarily.
- believes that AC problem is due to paraffin in AC and "light ends" but oil companies will not reveal the ingredients of the AC.
- QA System better than method specs.
 - no personnel conflicts.
 - first hand info on product since it is their mix and they know what to look for and how to adjust.
- state is asking for excessive density, the only way to obtain is to increase % AC which might result in rutting and flushing.
- density sampling, behind roller but prior to traffic being allowed on road.
- AC had been increased to increase life but leading to other problems.
- requirement for VFA (voids filled with asphalt) increased because of centerline joint problems.
- 1-9% voids permitted on joints and 1-5% voids permitted on rest of mat.

2.25 Material brought from Virginia

1. 1982 Specifications

2. Special Provisions for:

- Section 208 - Select Material Statistical Quality Control Specifications.
- Section 209 - Subbase and Aggregate Base Material.
- Section 212 - Bituminous Concrete.

- Bituminous Material Price Adjustment.
 - Aggregate Shoulder Rehabilitation.
 - Maintenance Overlay Density Requirements.
 - Hot Surface Asphalt Pavement Recycling.
 - Marshall Design of Bituminous Concrete Mixtures.
3. Virginia's Quality Assurance Program.
 4. Uniform Guide for Administering Quality Assurance Specifications.
 5. Marshall Design Guidelines.
 6. Revision - To Test Procedures.
 - Field Marshall.
 - Antistripping additive.
 - Abson Recovery Test.
 7. Bituminous Concrete Plant Certification Study Guide.
 8. Monitoring Program for Pugmill Mixed Aggregates and Bituminous Concrete.
 9. Production Control Plan for Pugmill Mixed Aggregates.
 10. Test Methods
 - Antistripping additives
 - Wet Track Abrasion
 - Field Determination of Specific Gravity of Compressed Bituminous Mixtures.

- Mechanical Analysis of Extracted Aggregates.
- Depth Test of Bituminous Concrete Base Courses.
- Asphalt Release Agents.
- Detection of Antistripping Additives in Asphalt Cements.
- Design of Bituminous Mixtures by the Marshall Method.
- Determining the Marshall Stability Volumetric Properties and Flow.
- Compatibility Test of Slurry Seal Mixtures.
- Stripping test for Bituminous Concrete.

3.0 WEST VIRGINIA

People interviewed

G. W. Steele

Chief Engineer - Construction, Maintenance and Materials

D. Long

Director of Materials Control, Soils and Testing Division

J. O'Leary

R. Sapp

Senior Engineering Technician

3.1 Quality Assurance System - General

- QA System has evolved since the 60's.

- started with certification of state technicians (voluntary for contractors), contractors were then required to have certified technicians, and then had to have a laboratory and eventually had to do testing [1972]).

- now testing is done by the contractor and verification is done by state.

- state now uses two levels of certification: inspector level and the technician level which also involve an exam on practical experience.

- contractor develops a quality control plan as per specification MP 401.03.50 and MP 401.02.23.

- the quality control plan prepared by the contractor becomes part of specifications under which the project is administered.

- contractors have found it cheaper to produce quality product and usually the QA technician has made money for the contractor.

- system has worked because a lot of state people were hired by contractor.

- state claims that it took 20 years for contractors to be capable and comfortable of operating under QA.
- occasionally have had to go to court to settle some claims. Very few contractors have won. Contractor can't sue state but has recourse through a Court of Claims.
- plants in West Virginia
 - 1-2 drum permanently in state.
 - 1-3 drum moving in and out of state.
 - 10 of old continuous mix plants.
 - 35 batch plants.
- state feels that contractor would probably have gone to end result testing, however, quality control plan forces him to control quality and to anticipate problems.
- system applies to capital construction and to maintenance
 - capital const. work to a job mix formula (JMF) plus master range
 - maintenance work to master range only
 - ***research revealed that after contractor got into process control the standard deviation for AC and stone was halved ***

3.2 Administration

- contractor must perform quality control test
- state has option of using contractor's tests to accept material or to run own acceptance tests
- if contractors tests are used for acceptance at least 10% of test are verified
- state is having some difficulties with contractors neglecting to make ash correction

- ash correction when done can be extrapolated to the next 3 tests
- if contractor does not meet own quality control plan, such as not taking random samples, state steps in to have situation remedied to the point of shutting down the plant

3.3 Acceptance

- decision made by district but reviewed by head office prior to acceptance
- AC and all sieves are controlled and price adjusted, multiple deficiencies are added. (see MP 401.02.23)
- density
- smoothness - treated as an attribute
- spot check for thickness

3.4 Price Reduction

- see MP 401.02.23
- evaluation is by plant not by project
- bonus system resulted in better quality work but state officials withdrew the bonus system because contractors getting bonus were the same ones that would have had 100% payment

3.5 Verification

- When contractor test results are used for acceptance the state performs a minimum of 10% verification tests.
- ML 25 covers verification and reruns.
- Head Office takes a "record" sample at rate of 1 per 5000 t of hot mix, this frequency will be lowered because it was originally developed when plant productions were around 600 t/day.

- if state results and contractor results are different and an assignable cause is identified the contractor is shut down until defect is corrected.
- District also takes verification samples. If any group of tests are different from others the reason has to be found before a decision on acceptance is made.
- hot mix paid by ton, contractor weighs, state spot checks by coring (minimum 15 cores), the contractor has option of asking for one recoring program. Some contractors have been caught cheating.
- 6" or 10" cores are taken, edges broken off and extraction performed. ASTM followed all the time.

3.6 Training

- formal certification.
- certification is valid for 3 years, after 3 years a committee reviews experience and if adequate the individual is re-certified.

3.7 Asphalt Cement

- supplied by contractor.
- because of absorption AC content tends to drop with time.
- paid as part of mix, however an escalation/de-escalation clause is also included (contractor has to provide proof of change in price).
- most AC supplied by Ashland, Chevron, jobbers.
- all quality data submitted by contractor to state on computer forms is certified.
- state - head office spot checks once every 30 - 40 days.
 - district samples every 50,000 t from trucks.
- same approval system used for emulsions and cutbacks.

- checking has not identified any serious problems with plan.
- AC content based on total mix.
- AC measured by extraction, therefore if absorptive aggregates are used may have to put 6.6 to get 6.3.
- most slags used are blast furnace slag.

3.8, 9. See part 3.1 and 3.2

3.10 Laboratory

- supplied by contractor. Spec requirement, used to be a bid item.
- only one laboratory permitted per contract to eliminate multi-laboratory variation.

3.11 Compaction

- usually roller pass method plus nuclear gauge is used, covered in MP 403.11.8.
- nuclear gauges used predominantly.
- any new paving is cored.
- for verification 8 - 10 cores are taken from surface courses.
- if lift is less than 1-1/2" roller passes only are used.
- target density is not tied to Marshall density.
 - using slags with density of 2.2 - 3.2.

3.12 Future of ERS

- still evolving.

3.13 Reaction by Contractor

- reluctant to get into it at first, now support it.

3.14, 15 Sampling and Testing

- truck sampling by contractor.
- contractor has option of taking hot bin aggregate samples and combine them mathematically, however every 5th sample has to be a hot mix sample from the delivery truck.
- ASTM is followed.
- test sample size dictated by the size of largest aggregate.
- state's monitoring samples are taken from the truck box.
- contractors may use any extraction method approved by ASTM D-2172 (90% of contractors use rotarex, state uses reflux). All methods require ash correction.
- ash correction; to date contractor has done one every 10 extractions, but now is switching to correction for every sample (Method used bunsen burner followed by muffle furnace). The correction of every sample has been brought on by use of slag and by use of aggregates with a lot of fines. State has been ashing all samples all along.
- all samples are washed

3.16 Field Marshall

- presently on most projects no routine field Marshalls are taken, however will switch to 1 per day for next construction season.
- field Marshalls have not been used extensively because of full gradation control (if gradation and AC do not change the Marshall values will not change).
- field Marshall will be required because of introduction of density requirement.

3.17, 18 Mix Design

- contractor prepares mix design, must supply to state 3 specimen for 5 combinations along with all data.
- 90% of mix design prepared by contractor 10% by oil companies. Consultants or commercial laboratories usually not involved.
- contractor can use Marshall, Hveen method etc., however, Marshall used almost exclusively.
- towns and cities use Department of Highways mixes.
- baghouse fines are not metered in at present but a specification has been written reducing permissible fine content. Contractor will have one year to upgrade equipment.
- mix design based on hot bin samples.
- aggregate information, state keeps last available information related to quality but not on quantity.
- state has right to alter mix designs.
- sometimes will let VMA slide if all other criteria are met (will look at Fuller curves).

3.19 Segregation

- have experienced problem with maintenance construction when trying to lay 2" lift with 2" material.
- some due to improper use of surge hoppers.
- no cronic problem associated with drum mixers.

3.20 Coring

- wet drilling.

- were used for extraction thickness, voids etc., but usually not for density.

3.21 Rutting

- isolated to heavy traffic areas, wearing is more of a problem (October 15 to May 15 use of studded tires is permitted).
- loads are heavy, coal trucks licensed to carry 60,000 lb will carry 120,000 lb, having trouble enforcing load limits
- all designs to date have based on "medium" traffic, will switch all expressway to "heavy" traffic design
- will increase AC content when Asphalt Institute does so

3.22 Recycled hot mix

- only 3 projects
- have permitted up to 20% RAP in surface courses and 25% in base courses
- RHM must meet all requirements of all virgin mix
- see Pg. 153 Spec 401.4.1
- final pen achieved around 60
- one RHM project had base work in winter, surface in summer, good performance
- all pre-engineering by contractor

3.23 Stripping

- not a problem
- what problems have been experienced have usually been associated with dust covers on aggregate

- quick test used
- drop 10 heated stones into heated AC in a can lid (stones and AC heated to mix temperature). Let cool to room temperature, pull out stones. 80% of submerged surfaces must be coated.

3.24 Visit to Contractor

- no contractor interviewed.

3.25 Material brought back from West Virginia

1. Materials Procedures (somewhat like MTC Special Provisions).

- MP 401.02.22 Design Testing of Bituminous Concrete
 - .23 Quality Assurance of Bituminous Priming Mixtures
 - .25 Certification of Asphalt and Tar Shipping Terminals
 - .03.20 Method of Test for Quality Assurance of Compaction of Bituminous Pavement Components by the Roller Pass Method
 - .50 Guide for Contractor's Quality Control of Bituminous Concrete
 - .51 Guide for Contractor's Quality Control of Contract Purchase Order, Bituminous Concrete, Maintenance Material
 - .52 Method of Quality Assurance Testing for Compaction on Resurfacing Projects
- 700.00.50 Procedure the Contractor's Compaction Testing on Bituminous Concrete
 - .04.21 Guide for Quality Control and Acceptance Plan for Embankment etc.... and Compaction Testing of Bituminous Concrete

2. Special Provision - 401.16 Surface Tolerances

3. Report - Bituminous Concrete Plant Dust Collection System, Effects of Using Recovered Dust in Paving Mix

4. Bituminous Concrete Inspection Programmed Construction Manual

5. Exam Questions.

4.0 PENNSYLVANIA

People Interviewed

R. J. Cominsky
Chief, Materials and Testing Division

P. Kandhal
Bituminous Engineer

C. Kline
Field Materials Control Engineer

J. Diversi
J. Hansarick
J. Yee

4.1 Quality Assurance System - General

- "Restricted Performance" specifications, not total ERS
- all acceptance tests performed by state in H.O. laboratory. In 1983, 88 people performed 15,000 extractions using 72 extractor (ASTM 2172 Method D)
- hot mix samples obtained behind paver by contractor at random locations selected by state (on most contracts)
- printout from automated computerized plant are used for acceptance without acceptance testing by state
- Present Q.A. system has been in place 3 years
- entire system is computerized
- only major jobs (1/3 of all contracts) are awarded under Q.A., rest is by method specs

4.2 Administration

- all acceptance decisions are made in Head Office
- state divided into 10 engineering districts each with a Construction Engineer and a Material Engineer
- Quality Assurance Engineers from Head Office check on day to day activities of districts
- district is responsible for day to day inspection
 - road inspector but no plant inspector
- plants and quarries are inspected at random

4.3 Acceptance Criteria

- asphalt cement content, #200 sieve and density
- criteria are converted into a percent within-limit for determination of lot acceptance.
- bonus point is given for excellent work on one lot to offset a poorer work on another lot. No direct bonus is given.
- percent - within-limit is based on standard deviation. Calculation and understanding of standard deviation do not seem to pose any problem in field.
- contractor also required to run and meet Marshall values. If not meeting requirements 90% of the time contractor has up to 150 t of mix to improve, if not improved operation is suspended
- specifications may be waived for assignable causes i.e. compaction around catchbasins

4.4 Price Reduction

- average statewide reduction 4%

4.5 Verification

- part of hot mix sample is saved and used for retesting should retesting be required
- retesting performed by state at H.O., but may be observed by contractor
- very few retest are normally called. State's original results are usually found to be correct.
- the result of the original lot has to match statistically the retest value, if not, retest values are used

4.6 Training

- winter schools used to update on latest developments
- state technician must pass NICET exam (National Institute for Certifying Engineering Technologists)
- contractor required to have a qualified but not necessarily a certified technician.
- if consultants are used for testing, they are also required to have NICET certification

4.7 Asphalt Cement

- asphalt cement supplied by contractor
- state maintains approved sources list
- state approves source initially, supplier must supply quality control plan
- supplier ships under certification plus supplier ships 1 sample per storage tank to state regardless of where asphalt is used.
- if failure is found testing is increased (category 2) if still problem the supplier cannot ship any AC (See Specs)
- % AC is calculated on total mix

- cost of AC is built into the hot mix item
- if incorrect grade of AC shipped to contractor and used, discussion is between state and supplier, not contractor

4.8 Aggregates

- mostly use quarried material but also river and glacial gravels
- aggregates must come from approved sources.
- testing by district varies with contractor's quality control plan. occasionally H.O. samples as well.
- one sample per source is taken for quality check each year

4.9 Credibility

- see 4.1, 4.2, and 4.5
- contractor may take own tests but they are not used, he has option of requesting and of observing retesting

4.10 Laboratory

- requirements of contractor's laboratory outlined by specs (see bulletin 27)

4.11a Density

- requirement is 92% of theoretical maximum density
- cores shipped in plastic tubes, cores separated by cardboard

4.11b Thickness

- measured from cores
- not a pay item
- requirements covered by spec but nothing very formal

4.12 Future of ERS

- still evolving

4.13 Reaction by Contractors

- reluctant to get into it at first, suspicious, now support it.

4.14, 15 Sampling and Testing

- loose samples of hot mix taken behind paver at random location (outer 2 ft excluded). Vertical sided scoop used to gather sample. Location of sample is the same as that of core which will be used to measure density.
- no problems with high AC due to tack coating have been identified
- in original study found less variation in road samples than truck box samples
- safety people have prohibited use of truck sampling
- sample taken by contractor's technician
- three days normally taken from time of sampling to acceptance of lot
- sample size 4500g
- test size binder and base - 1000g
surface - 500g
- test size and procedures defined in Pennsylvania's test manual

4.16 Marshall Samples

- contractor performs tests
- must meet requirements 90% of time
- if above not met, contractor has 150 t in which to correct mix, if not corrected is shut down
- contractor must keep control chart of Marshall values.

4.17, 18 Mix Design

- mix designs prepared by contractor under observation of District Construction Engineer
- minimum VMA 15% surface and 13% binder
- sample not washed because of washing action of reflux testing
- baghouse fines - see paper by Prithui Kandhal
- max % fines is 7%
- experiencing some problem with gravels because of absorption (will not use aggregates with an absorption of water of 2.5% or more)

4.19 Segregation

- no criteria
- dealt with by inspector, if seen contractor asked to make repair
- have had problems with segregation from 24 ft pavers
- only about 9 drum mixers in state, must meet same requirements as batch plants

4.20 Coring

- cores taken at same location as hot mix sample
- cores used to determine density and thickness but not used for extractions because of problems with cut surfaces and fines variability
- roads are tack coated but tack does not seem to affect density

4.21 Rutting

- slight problem in Pittsburgh area
- some rutting at intersections

- problem overcome by VMA and density requirements
- predominantly use quarried stone although slags, river gravels and glacial gravels are also used.
- 1/3 of recent mix designs have had to be modified to meet new VMA requirements

4.22 Recycling

- RAP given to contractor, RAP removal is a separate item
- contractor can use 5-10% RAP, normal mix requirements must be met
- in past 11% RAP or more, only density must be met under QA system other criteria handled by method spec, now must meet same requirements as all virgin mixes.
- RHM has only been used in binder course
- 30% RAP highest ratio tried
- RHM experience 3 years
- aim of state was to have 25% RHM but industry is bidding lower on all virgin mixes
- no pre-engineering done by state
- contractor selects % RAP

4.23 Stripping

- no problem
- probably density requirement has helped
- anti-stripping agents are normally not used

4.24 Visit to Contractor

- no contractor was interviewed.

4.25 Material brought back from Pennsylvania

1. 1983 Specifications.
2. Spec Amendments
 - General Restricted Performance Specifications
 - Plant Mixed Bituminous Concrete Courses
 - Bituminous Concrete Base Courses
 - Bituminous Concrete Binder Courses
 - Recycled Plant-Mixed Bituminous Concrete Courses
3. Computer Printouts of Quality Assurance data base.
4. Field Test Manual
5. Bulletin 25 Specification for Bituminous Materials
6. Bulletin 27, Mix Design Procedures
7. Circular - Recycling of Bituminous Pavements
8. Research Report - Statistical Acceptance of Bituminous Paving Mixtures.
9. Quality Assurance Manual
10. Development of Q.A. - Guidelines